Ensete Superbum (ROXB.) Cheesman: A Rare Medicinal Plant with Neuroprotective and Anti-Parkinson Applications

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ABSTRACT
Parkinson disease (PD) is a progressive, neurodegenerative disease characterized by the loss of dopaminergic neurons, which cause motor and non-motor disabilities.Its pathogenesis includes the oxidative stress, dysfunctions of the mitochondrion, neuroinflammation, and aggregation α-synuclein.Existing treatments offer only symptomatic help and are linked with long-term restriction, which reflects the necessity of safer, multitarget options.*Ensetesuperbum (Roxb.)*Cheesman is a medicinal plant that is of the Musaceae family and has been used in Indian ethnomedicine to treat inflammation, diabetes and urinary disorders.Phytochemical analysis indicates flavonoids, phenols, alkaloids, tannins, glycosides, which are antioxidants and anti-inflammatory compounds.These compounds can be involved in the neuroprotection process through mitigating oxidative stress, altering the inflammatory processes, and maintaining neuronal viability.This review briefly encapsulates botanical, phytochemical, and pharmacological properties of *E. superbum* and shows its possible applicability in Parkinson disease.Nevertheless, its therapeutic efficacy and safety still need to be confirmed in the future through additional experimental and clinical research.

Keywords: *Parkinson disease; Ensetesuperbum; Neuroprotection; Phytochemical; Oxidative stress; Molecular docking.*
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INTRODUCTION
The second most prevalent neurodegenerative disorder to Alzheimer disease is Parkinson disease (PD) which is almost 12 percent of individuals over 60 years of age all over the world.Progressive degeneration of dopaminergic neurons in the substantia nigra pars compacta causes the disease, which results in the loss of dopamine in the nigrostriatal pathway[1,2].The clinical symptoms of Parkinson's disease are motor symptoms, including resting tremors, muscular rigidity, bradykinesia, and postural instability, and non-motor symptoms, including cognitive dysfunction, depression, autonomic disturbances, and sleep disorders[3].Parkinson Disease pathophysiology consists of various interrelated processes such as oxidative stress, mitochondrial dysfunction, neuroinflammation, α-synuclein aggregation, excitotoxicity, and apoptotic death of neurons[4,5].One of the key factors to dopaminergic neuronal degeneration in Parkinson disease is regarded as oxidative stress.Overproduction of reactive oxygen species (ROS), and the loss of antioxidant defense mechanisms lead to lipid peroxidation, mitochondrial damage, DNA oxidation, and neuronal apoptosis [6].Moreover, neuroinflammatory pathways initiated by activated microglia and inflammatory cytokines including tumor necrosis factor- alpha (TNF- alpha), interleukin-1 -beta and interleukin-6 also enhance neuronal degeneration [7].The aggregation of α-synuclein protein and the development of Lewy bodies also have crucial roles in the pathogenesis and progression of the diseases[8].

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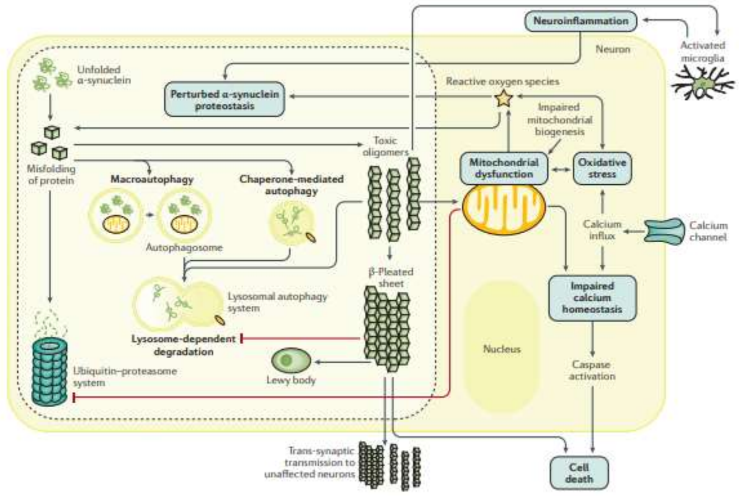

Figure 1: Molecular mechanisms involved in Parkinson disease

The existing therapeutic methods are primarily aimed at the symptomatic treatment with the use of levodopa, dopamine agonists, monoamine oxidase-B inhibitors, catechol-O-methyltransferase inhibitors, and anticholinergic agents.These drugs can temporarily enhance motor symptoms, but in the long run, they are often linked to such adverse effects as dyskinesia, hallucinations, motor fluctuations, and decreased therapeutic efficacy with time[2.]Moreover, the current treatments are not effective in preventing the progressive neuronal degeneration.This has therefore led to the mounting scientific interest on medicinal plants and natural compounds that have multitarget neuroprotective properties and which have relatively safer profiles of therapeutic use.Due to the abundance of phytochemical compounds, medicinal plants have been of great value in the past as sources of therapeutic agents used in the treatment of neurological disorders.Flavonoids, alkaloids, phenolic acids, glycosides, and terpenoids are plant-derived compounds, which have been shown to have antioxidant, anti-inflammatory, antiapoptotic, and neuroprotective effects in experimental neurodegenerative conditions[9,10.]A number of phytochemicals have the potential to scavenging free radicals, inhibiting inflammatory signaling pathways, mitochondrial integrity, neurotransmitter metabolism, and neuronal apoptosis, which could potentially have therapeutic value against Parkinson disease[4].*Ensetesuperbum (Roxb.)*The Cheesman is a rare medicinal plant that is a member of the family Musaceae and is receiving increasing ethnopharmacological attention due to its various traditional medicinal uses.The distribution of the plant is mostly in tropical and subtropical areas of India, especially in the Western and Eastern Ghats.Historically, various plant components such as seeds, rhizomes, pseudostem, and inflorescence have been employed in the treatment of urinary calculi, kidney diseases, diabetes, inflammation, digestive diseases, and microbial infections[11].Prelude phytochemical studies have indicated the existence of flavonoids, phenolic compounds, tannins, saponins, glycosides, and alkaloids which are generally known to have antioxidant and anti-inflammatory properties[12.]The anti-Parkinson activity of *Ensete superbum* is scarcely directly evidenced, but the phytochemical composition of this substance is a strong indicator of its possible neuroprotective use.A number of flavonoids and phenolic compounds found in medical plants have shown to reduce oxidative stress, inhibit monoamine oxidase activity, alter inflammatory signaling pathways, maintain mitochondrial function, and protect dopaminergic neurons in models of[13,9.]Additionally, recent breakthroughs in network pharmacology, molecular docking and computational drug discovery has hastened the discovery of natural compounds present in plants that are targeting various pathological pathways that are related to neurodegenerative diseases[14-16.]

PHYTOCHEMISTRY OF *ENSETE SUPERBUM*

The interest of scientists in phytochemicals of medicinal plants is due to a wide range of their pharmacological characteristics and pharmacological use in chronic diseases. The secondary metabolites that have been reported to have antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and neuroprotective effects include flavonoids, alkaloids, phenolic acids, tannins, glycosides, terpenoids, and saponins[12.] Over the past few years, it has been shown that phytochemicals with the potential to mitigate oxidative stress and neuroinflammation can have important therapeutic effects against neurodegenerative diseases such as Parkinson's disease, Alzheimer's disease, and Huntington's disease[17]

Early phytochemical studies on *Ensete superbum* have found that the plant extracts contain a number of biologically active compounds such as flavonoids, phenolic compounds, tannins, alkaloids, saponins, glycosides, steroids, and carbohydrates[11.] These are important compounds that are thought to add to the medicinal value attributed to the plant. The use of methanol, ethanol, aqueous and hydroalcoholic extracts to extract solvents have shown different phytochemical profile based on the extraction polarity and part of the plant used. Among them, flavonoids and phenolics are considered as the predominant bioactive compounds due to their high antioxidant and cytoprotective properties.

Flavonoids are polyphenols that are prevalent in medicinal plants and are known to have neuroprotective effects in animal models of Parkinson. A number of flavonoids, including quercetin, rutin, kaempferol, luteolin, and catechin, were shown to provide the ability to scavenge reactive oxygen species, mitigate lipid peroxidation, modulate mitochondrial activity, and suppress inflammatory cytokines [9,10.].Flavonoids can also prevent neuronal apoptosis by altering the activity of signaling pathways, including PI3K/Akt, MAPK, and NF- 0 -B.

Antioxidant defence mechanisms are also associated with phenolic compounds that are found in medicinal plants. Polyphenols can neutralize free radicals and chelate metal ions that play a role in oxidative neuronal damage[4.] Over-oxidative stress in Parkinson disease causes dysfunction in the mitochondria and death of the dopaminergic neurons. Phenolic compounds can thus alleviate neuronal damage by increasing the levels of endogenous antioxidant enzymes like superoxide dismutase, catalase and glutathione peroxidase. Other studies have also found that phenolic compounds inhibit neuroinflammation by decreasing the levels of tumor necrosis factor-alpha, interleukin-1b, and inducible nitric oxide synthase[7.]

Medicinal plants have been of great interest due to the neuropharmacological activities of alkaloids that have been discovered in them. A large number of plant alkaloids have an inhibitory action on monoamine oxidase-B (MAO-B), a major therapeutic goal in the management of Parkinson disease. The MAO-B inhibition decreases the degradation of dopamine and lessens the oxidative stress that is produced during dopamine metabolism [13.] Despite the fact that very little has been done to characterize the alkaloid constituents that are found in *Ensetesuperbum*, presence of nitrogen-bearing phytoconstituents is reported hence the potential of neuroprotection has the potential to be further developed.

Saponins and glycosides found in *Ensete superbum* can further help in the stabilization of membranes, anti-inflammatory effects as well as protection of cells against oxidative damage. It has been reported that saponins can modulate apoptotic signaling pathways and enhance the mitochondrial activity in neurodegenerative models [18.] On the same note, plant glycosides have also exhibited antioxidant and antiapoptotic properties that could lead to the survival of neurons in an oxidative stress environment.

Medicinal plants often have pharmacological relevance due to synergistic effects of a combination of phytochemicals and not necessarily through the action of a single compound. This multitarget pharmacological effect is especially significant in neurodegenerative diseases such as Parkinson's where the pathogenesis of the disease is characterized by a large number of interrelated pathological pathways, including oxidative stress, neuroinflammation, mitochondrial dysfunction, α-synuclein aggregation, and apoptosis [2.] Thus, the medicinal plants that have a wide range of phytochemical classes can be potentially more effective in terms of their therapeutic effects than a single-target synthetic drug.

NEUROPROTECTIVE EFFECTS OF MEDICINAL PLANTS IN PARKINSON DISEASE

The increased incidence of neurodegenerative disorders and the constraints of the traditional pharmacotherapy have greatly triggered the scientific interest of medicinal plants as the possible neuroprotective agents. Parkinson is a multifactorial disease, which can be characterized by oxidative stress, mitochondrial dysfunction, neuroinflammation, excitotoxicity, protein aggregation, and apoptotic cell death. As these pathological processes are interrelated, therapeutic agents with multitarget pharmacological effects can have more clinical advantages compared to those with single-target drugs[2.]

Oxidative stress is also known to be one of the most common causes of dopaminergic neurons degeneration in Parkinson disease. Overproduction of reactive oxygen species causes lipid peroxidation, mitochondrial damages, DNA oxidation, and neuronal apoptosis in the substantia nigra[4.] The antioxidants found in plants, including flavonoids, phenolics, tannins, and alkaloids showed significant neuroprotective properties by neutralizing free radical and indirectly boosting the endogenous antioxidant defenses. A variety of flavonoids such as quercetin, rutin, kaempferol, luteolin, and catechin have been demonstrated to have the ability to decrease oxidative neuronal damage and enhance dopaminergic neuronal survival in experimental models of Parkinsonian disease[9,10.]

The other significant pathological hallmark in Parkinson disease is mitochondrial dysfunction that plays a significant role in neuronal degeneration. Dysfunctional mitochondrial respiration causes ATP depletion, overproduction of reactive oxygen species as well as activation of apoptotic pathways. Various natural products of medicinal plants have shown to have protective effects on mitochondrial dysfunction by stabilizing mitochondrial membrane potential, enhancing cellular respiration and alleviating oxidative damage[19] The polyphenolic substances found in traditional medicinal plants can also regulate biogenesis of the mitochondria and maintain the neuronal energy metabolism, thus sparing the dopaminergic neurons of the degeneration.

Active microglial-mediated neuroinflammation and inflammatory cytokines are important in the progression of the disease in Parkinson. Activated microglial cells release pro-inflammatory mediators such as tumor necrosis factor-1, interleukin-1, nitroxide and reactive oxygen species that cause neuronal damage [7.] Many medicinal compounds, which are produced by plants, have exhibited anti-inflammatory effects by inhibiting NF-kB-signaling pathways and preventing the production of inflammatory cytokines. Some of the phytochemicals that have been studied widely in terms of their neuroprotective anti-inflammatory properties in the model of neurodegenerative diseases are luteolin, quercetin, curcumin, and resveratrol [10,17].

The protein misfolding and α-synuclein aggregation are characteristic pathological aspects of the parkinson disease. Aggregation of α-synuclein leads to the formation of Lewy bodies in neuronal cells, which leads to mitochondrial dysfunction, oxidative stress, dysfunction of synapses, and apoptosis of neurons [8]. A number of plant-based compounds have been shown to prevent aggregation of α-synuclein and minimize the related neurotoxicity. Experimental studies have demonstrated the inhibitory effect of polyphenols including epigallocatechin gallate, curcumin and baicalein in protein aggregation[20].

Another important process that plays a role in the pathology of Parkinsonism is apoptotic neuronal death. Intrinsic apoptotic pathways are activated by oxidative stress, mitochondrial dysfunction, and inflammatory mediators leading to caspase activation and neuronal degeneration. Antiapoptotic effects of medicinal plant-derived compounds can be mediated by anti-caspase activation, anti-Bcl-2 family proteins, and anti-survival signaling pathways (PI3K/Akt and MAPK) [21]. These multitarget neuroprotective activities also reinforce the therapeutic usefulness of medicinal plants in the management of Parkinson Disease.

A number of medicinal plants such as *Mucuna pruriens*, *Withaniasomnifera*, *Bacopa monnieri*, *Curcuma longa,* and *Ginkgo biloba* have shown good neuroprotective activity in laboratory and clinical trials of Parkinson disease. These plants have antioxidant, anti-inflammatory, antiapoptotic, and dopaminergic regulation properties, which help in protecting the neuron and improving the symptoms[22,17].

The growing intertwining of ethnomedicine, phytochemistry, molecular docking, and network pharmacology have rapidly increased the discovery of plant-based neuroprotective compounds. Plants with medicinal potential that can attack more than one pathological pathway can thus offer some hopeful alternatives in the development of safer and more effective therapeutic agents against Parkinson disease and other neurodegenerative diseases.

PHARMACOLOGICAL ACTIVITIES OF *ENSETE SUPERBUM*

Medicinal plants have various pharmacological properties due to the availability of many bioactive phytoconstituents that can bind with different biological targets. Over the past years, scientific studies on *Ensete superbum* have shown a number of therapeutic effects such as antioxidant, anti-inflammatory, antimicrobial, antidiabetic, antiurolithiatic and cytoprotective effects.

Antioxidant activity is regarded as one of the most significant pharmacological properties of medicinal plants since oxidative stress is one of the major causative factors of cell damage and neurodegradation. A number of research articles have indicated that *Ensetesuperbum* extracts have an excellent free radical scavenging activity toward reactive oxygen species, and lipid peroxidation. The plant contains phenolic compounds and flavonoids that can donate and neutralize the free radicals or electrons in order to minimize oxidative stress on the cellular macromolecules [12]. The antioxidant phytochemicals can also stimulate the endogenous antioxidant enzymes including catalase, superoxide dismutase, and glutathione peroxidase, which enhances cellular protective mechanisms against neuronal injury caused by oxidative stress[4].

Ensete superbum also has anti-inflammatory activity which makes it have a great role in pharmacological relevance. Chronic inflammation is linked with the elevated synthesis of the inflammatory mediators such as tumor necrosis factor-alpha, interleukins, nitric oxide and prostaglandins which play a role in tissue damage and neurodegeneration. Flavonoids and phenolic compounds found in plants have been shown to inhibit the inflammatory signal pathways like the NF-kB and cyclooxygenase pathways [7]. Early research indicates that extracts of *E. superbum* have the potential to inhibit inflammatory pathways and minimize oxidative damage, which would help in the potential use of neuroprotective effects.

Among the most widely documented traditional uses of *Ensete superbum* is its antiurolithiatic effect. In indigenous medicine, the plant has the traditional use of the treatment of urinary calculi and kidney stone disorders using the seeds of the plant. It has been experimentally shown that plant extracts can prevent the formation of calcium oxalate crystals and prevent the deposition of stones in the renal tissue [11]. The effect of antioxidant phytochemicals, diuretic effect and regulation of urinary biochemical parameters may be the combined action of the antiurolithiatic effect. Though not directly associated with Parkinson disease, this activity demonstrates the pharmacological potential and safety of the plant in terms of therapeutic use.

Ensete superbum has also been reported to have antimicrobial activity against some bacterial and fungal pathogens. Preliminary microbiological studies showed that Methanolic and aqueous extracts of the plant were inhibitory against Gram-positive and Gram-negative microorganisms. This can be due to the antimicrobial effects of tannins, phenolics, and alkaloids that have the ability to interfere with microbial cell membrane and block microbial enzyme systems [23]. Antimicrobial effect can also help in decreasing the inflammatory effects that are related to infections and oxidative stress.

Another essential pharmacological effect related to medicinal plants containing polyphenolic compounds is antidiabetic activity. Oxidation stress and chronic inflammation are some of the reasons that lead to insulin resistance, and diabetic complications. A number of flavonoids and phenolics found in plants have been shown to have the capacity to control glucose metabolism, enhance insulin sensitivity, and inhibit oxidative damages related to hyperglycemia [24.] The medicinal uses of *E.superbum* in the management of diabetes are therefore supported by traditional medicinal uses that may incorporate the existence of biologically active compounds that could regulate metabolic and inflammatory pathways.

Ensete superbum also has a pharmacological potential to be applied in neuroprotective methods due to the fact that oxidative stress and inflammation are the key pathological processes in Parkinson disease. Antioxidant phytochemicals could help prevent dopaminergic neurons to be damaged by reactive oxygen species, and anti-inflammatory compounds could inhibit neuroinflammatory signaling pathways that can lead to neuronal degeneration. Moreover, some of these alkaloids and flavonoids can possibly control the monoamine oxidase activity and mitochondrial functioning, thus, helping to protect neurons[13.]

Some antioxidant and anti-inflammatory medicinal plants have shown to have neuroprotective effects in experimental Parkinsonian models [9,10.]Because *Ensete superbum* shares similar phytochemical properties, more in vitro and in vivo experiments are required to scientifically prove the anti-Parkinson potential of *Ensete superbum*. The extensive pharmacological analysis such as toxicity tests, mechanistic studies, and identification of molecular targets will hence be crucial in determining its therapeutic potential in neurodegenerative diseases.

***Ensete superbum* as an anti-Parkinson**

Parkinson's disease (PD) is a progressive neurodegenerative condition, which is associated with degeneration of dopaminergic neurons and loss of dopamine in the substantia nigra. The key pathological processes in the progression of the disease are considered to be oxidative stress, mitochondrial dysfunction, neuroinflammation, and α-synuclein aggregation[2,4].The shortcomings of the existing treatment interventions have prompted the growth of interest in medicinal plants with multitarget neuroprotective effects.

Flavonoid and phenolic-rich medicinal plants have shown considerable neuroprotective effects in experimental Parkinsonian models. Quercetin, luteolin, rutin, and catechin are suggested to alleviate the oxidative stress and inhibit the effects of inflammatory factors in addition to enhancing neuronal survival[9,10]. As *Ensete superbum* is a source of flavonoids, phenolics, tannins, and alkaloids, the plant can have analogous neuroprotective effects against dopaminergic neuronal degeneration.

One of the key factors in neuronal damage in Parkinson disease has been identified as oxidative stress. Overproduction of reactive oxygen species results in lipid peroxidation, mitochondrial damage, and activation of apoptotic pathways. The antioxidant phytochemicals found in *E. superbum* can thus contribute to inhibiting the oxidative neuronal damage by free radical scavenging and promoting endogenous antioxidant defense mechanisms. Moreover, anti-inflammatory agents of medicinal plants have the potential to inhibit microglial stimulation and production of inflammatory cytokines related to neurodegeneration [7.]

MOLECULAR DOCKING AND COMPUTER SIMULATIONS

Recent innovations in network pharmacology and computational biology have had a considerable impact on discovering neurodegenerative disease-related natural products to use as a drug. Molecular docking has been extensively used to model interactions between phytochemicals and target proteins related to Parkinson disease such as monoamine oxidase-B (MAO-B), 8-synuclein, dopamine receptors and catechol-O-methyltransferase (COMT). These computational methods are used to obtain possible lead compounds that have a good binding affinity and pharmacological activity prior to experimental verification [14.]

Flavonoids and phenolic compounds of plant derivatives have shown to bind strongly with proteins associated with oxidative stress and neurodegeneration. Past docking studies noted that quercetin, luteolin, kaempferol, and catechin have high affinity to MAO-B and other neuroprotective targets and might be useful in slowing down dopamine degradation and neuronal oxidative damage [10.]*Ensete superbum* may have anti-Parkinson active bioactive constituents and since the plant has related classes of phytochemicals, computational screening can be used to identify the active ones.

Network pharmacology has also become a significant resource to studying multitarget interactions between phytochemicals and disease-related pathways. In contrast to the traditional single-target drug delivery methods, medicinal plants can have therapeutic effects simultaneously on a variety of signaling pathways. These pathways in Parkinson Disease involve oxidative stress regulation, inflammatory signaling, mitochondrial functioning, and apoptotic processes [2.] Computational pathway analysis can thus reveal information on the synergistic neuroprotective actions of phytochemicals found in *Ensete superbum.*

Prediction models in silico can also be used to assess drug-likeness, pharmacokinetic behavior and blood-brain barrier permeability of plant-derived compounds. Absorption, distribution, metabolism, excretion, and toxicity (ADMET) parameters are key during their initial discovery of drugs since neuroprotective drugs need to reach the central nervous system to provide treatment. Computational screening can thus aid in the screening of phytoconstituents that could then be subjected to further neuropharmacological studies.

Blood Brain Barrier Prediction and ADMET

One significant step in developing neuroprotective agents in the treatment of Parkinson disease is the assessment of pharmacokinetic properties. Along with therapeutic efficacy, potential drug candidates should have desirable absorption, distribution, metabolism, excretion and toxicity (ADMET) properties to guarantee sufficient bioavailability and safety. In the case of compounds to neurodegenerative disorders, blood–brain barrier (BBB) is especially relevant since therapeutic agents need to penetrate the central nervous system to be able to protect it [25].

Various plant-based flavonoids and phenolic compounds have shown adequate pharmacokinetic characteristics and intermediate blood-brain barrier permeability in both computational and experimental researches. Such compounds as quercetin, luteolin, and kaempferol have demonstrated the capacity to enter neuronal tissues and inhibit neuronal damage induced by oxidative stress [26].

Despite a dearth of specific ADMET research on *Ensete superbum* phytoconstituents, flavonoids and phenolic compounds indicate that they may have neuropharmacological significance. Subsequent research incorporating phytochemical characterization and computational pharmacokinetic analysis can be used to determine compounds with appropriate BBB permeability and therapeutic potential against Parkinson disease.

SAFETY AND TOXICOLOGICAL CONCERNS

Assessment of toxicity and safety must be performed in the development of plant-derived therapeutic agents of neurodegenerative disorders. Medicinal plants are usually regarded to be safer compared to synthetic drugs, but the likelihood of biologically active phytochemicals to cause adverse effects may still occur based on the dosage, exposure time, and route of administration. Consequently, there is a need to conduct toxicological evaluation to determine the therapeutic safety profile of medicinal plants to be used on long-term basis in chronic illnesses like Parkinson disease.

Early pharmacological research on *Ensetesuperbum* has all centered on physicochemical composition and pharmacological activities of the plant, and toxicological research has been conducted sparingly. The potential of the plant in the traditional medicinal use in urinary and inflammatory diseases indicates a fairly good safety profile, but scientific confirmation by acute, subacute, and chronic toxicity experiments is yet to be achieved. Hepatic, renal, neurological, and hematological parameter assessment is of particular importance in preclinical assessment of neuroprotective agents.

Flavonoids and phenolic compounds occurring in plants are mostly linked with low toxicity and positive antioxidant effects at therapeutic levels. Nevertheless, the consumption of some of these phytochemicals should be moderate since they can disrupt the metabolism or alter the activity of drug-metabolizing enzymes or have pro-oxidant effects when they are taken in excess [12]. Thus, to achieve a reproducible pharmacological activity and safety, standardization of dosage, extraction, and phytochemical compounds is necessary.

Toxicological screening is also significant in assessing the blood-brain barrier safety, neurotoxicity and possible drug interactions. As patients with Parkinson Disease usually take several drugs, the exploration of the interactions between herbs and drugs is especially significant when medicinal plants are considered as complements to conventional treatment. The use of *Ensete superbum* in future should be thus accompanied by extensive toxicological profiling and pharmacokinetic assessment of the organism to determine its safety as a neuroprotective agent.

CONCLUSION

Ensete superbum (Roxb.) Cheesman is a rare medicinal plant that has significant ethnopharmacological potential and therapeutic promise. Its traditional application and phytochemical diversity, such as flavonoids, phenolics, alkaloids, tannin, and glycosides, contribute to its applicability in pharmacological studies. These are antioxidant and anti-inflammatory compounds that will be important in dealing with major pathological processes of Parkinson disease including oxidative stress, neuroinflammation, and mitochondrial dysfunction.Even though its phytochemical profile has anti-Parkinson effects, experimental evidence is still scanty. New opportunities to find active neuroprotective compounds are offered by the advances in molecular docking and computational methods. Nevertheless, additional in vitro, in vivo and clinical research is necessary to confirm its effectiveness and safety. Altogether, E. superbum is a promising source of developing the plant-based therapies of the Parkinson disease.

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